FIG. 1

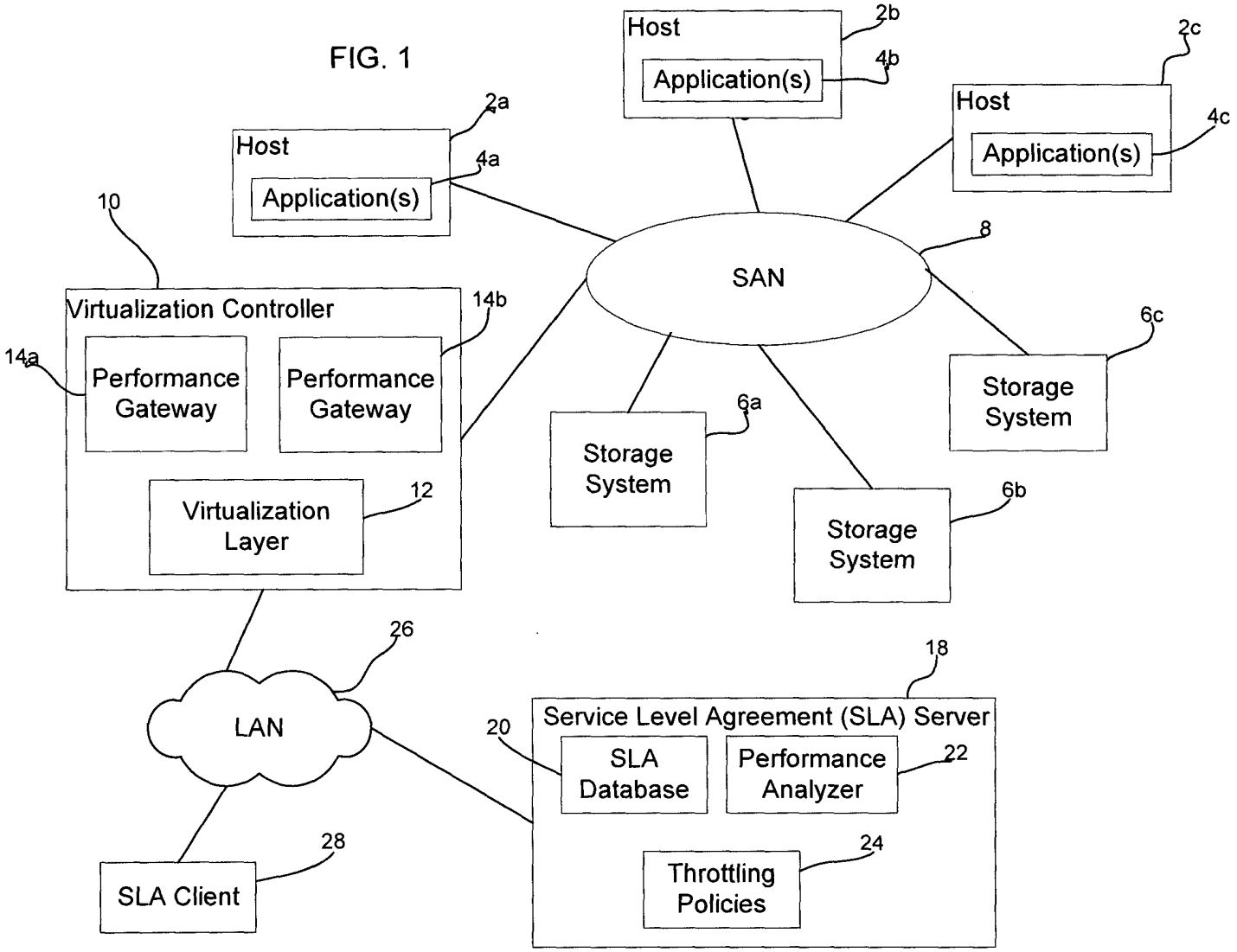

Host
Application(s)
2a
4a
Host
Application(s)
2b
4b
Host
Application(s)
2c
4c
10
Virtualization Controller
Performance Gateway
Performance Gateway
14a
14b
Virtualization Layer
12
SAN
8
Storage System
6a
Storage System
6b
Storage System
6c
LAN
26
Service Level Agreement (SLA) Server
18
SLA Database
20
Performance Analyzer
22
Throttling Policies
24
SLA Client
28

FIG. 2

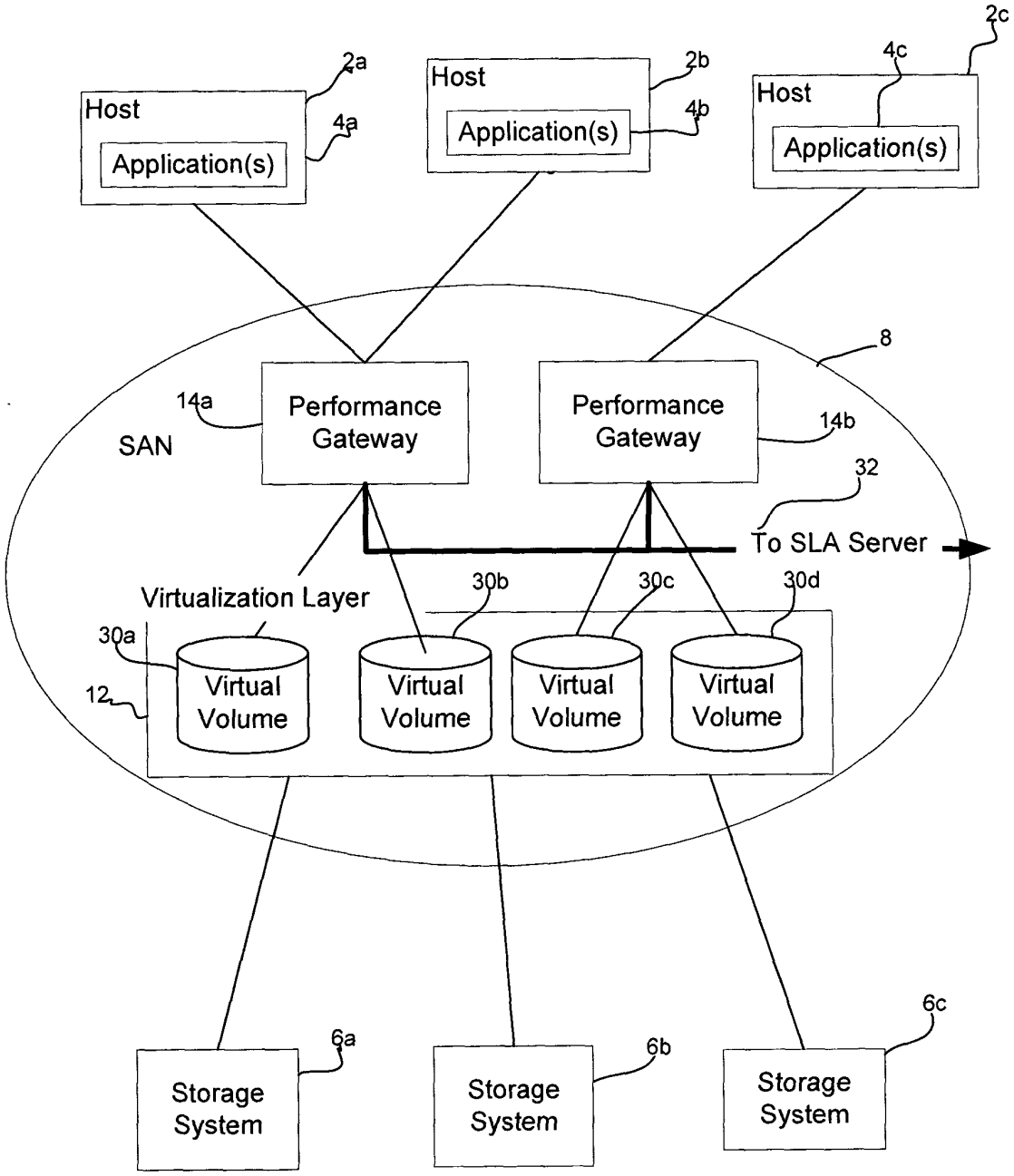
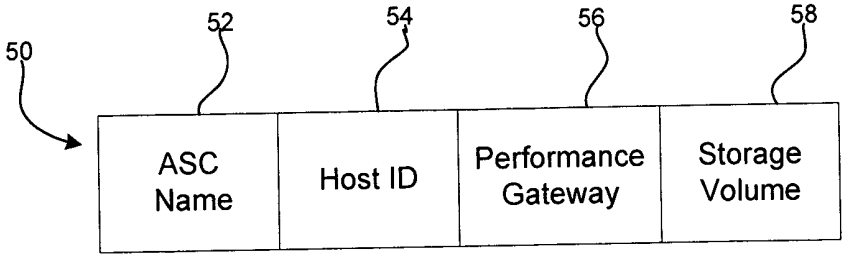
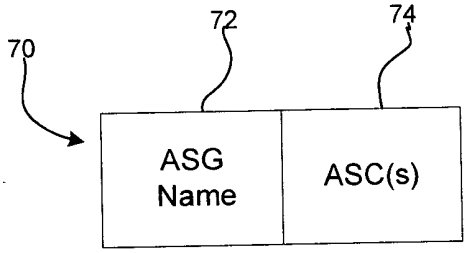

2a
Host
Application(s)
4a
2b
Host
Application(s)
4b
2c
4c
Host
Application(s)
8
14a
SAN
Performance Gateway
Performance Gateway
14b
32
To SLA Server
Virtualization Layer
30b
30c
30d
30a
12
Virtual Volume
Virtual Volume
Virtual Volume
Virtual Volume
6a
Storage System
6b
Storage System
6c
Storage System

FIG. 3



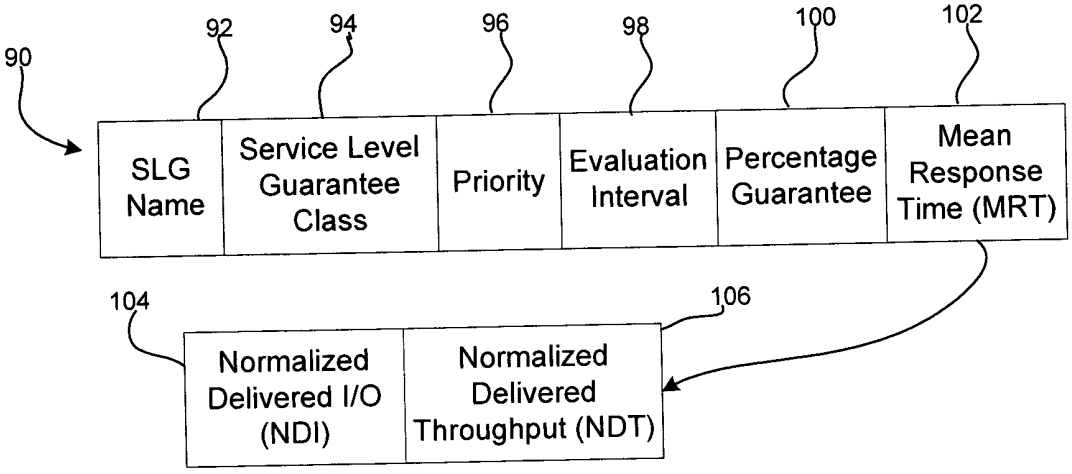
Application Storage Connection (ASC) Record

FIG. 4



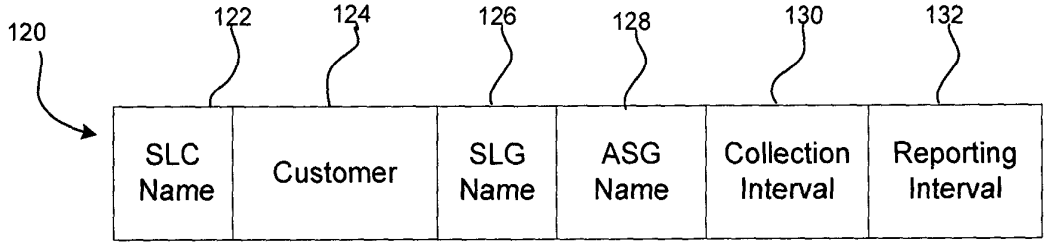
Application Storage Group (ASG) Record

FIG. 5



Service Level Guarantee (SLG) Record

FIG. 6



Service Level Commitment (SLC) Record

FIG. 7

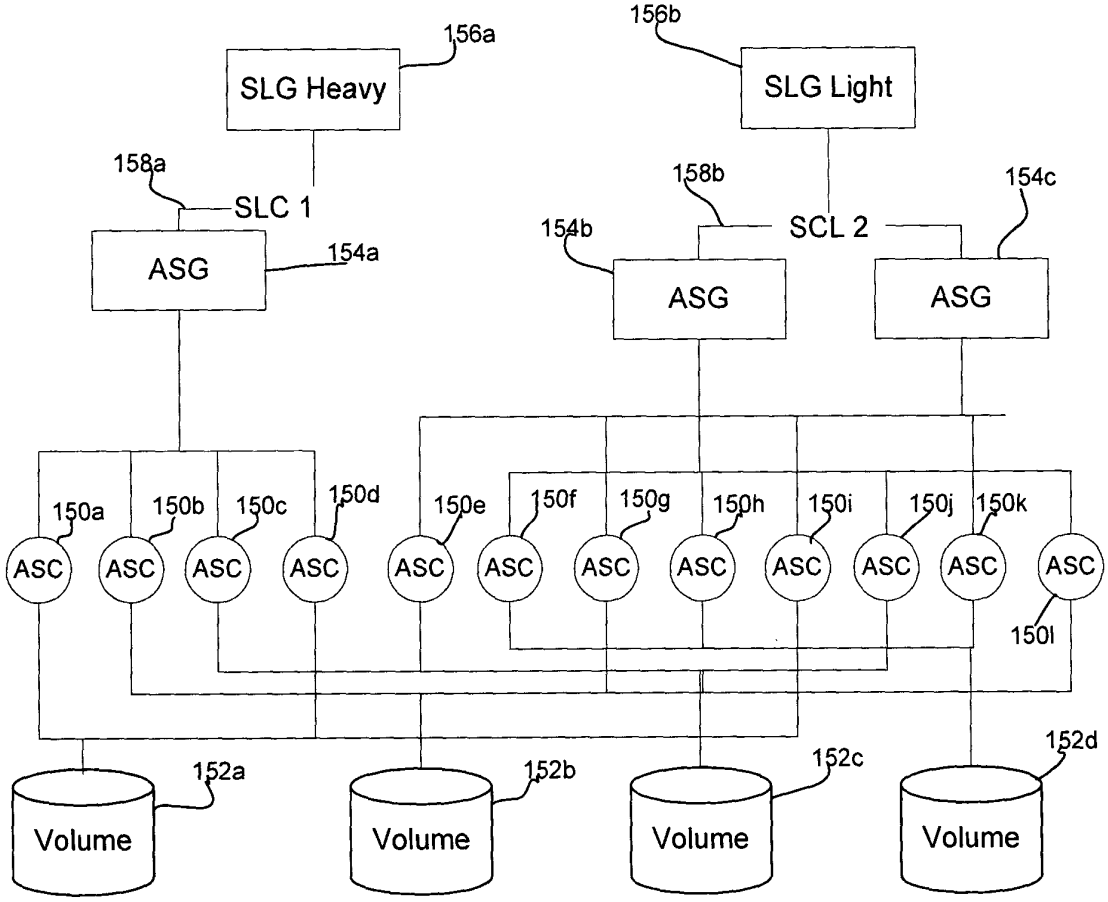


FIG. 8

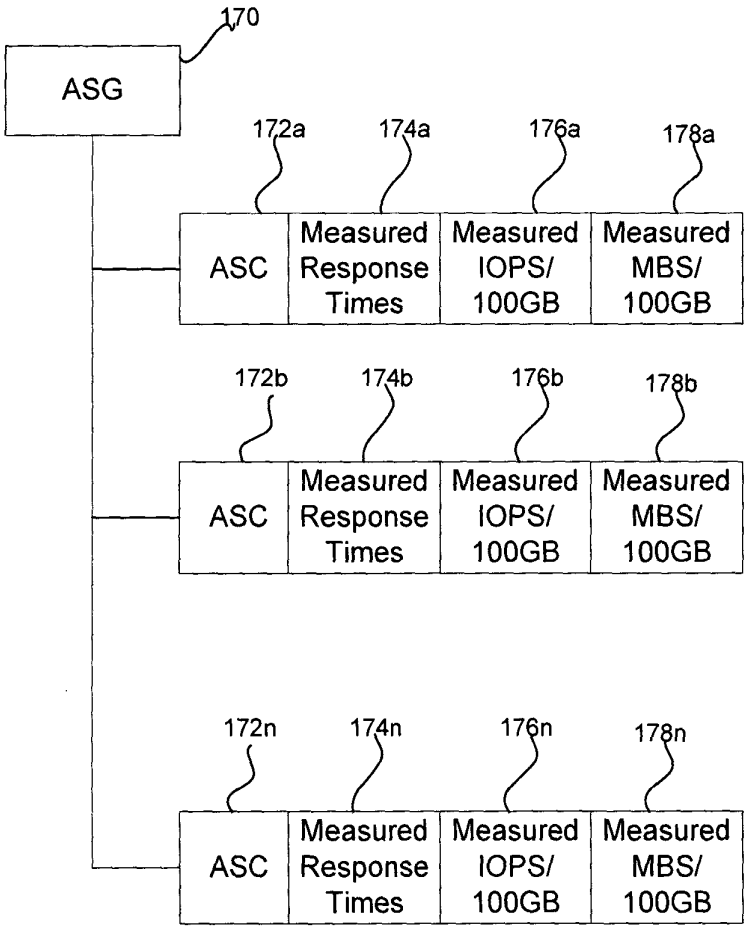

170
ASG
172a
174a
176a
178a
ASC
Measured Response Times
Measured IOPS/ 100GB
Measured MBS/ 100GB
172b
174b
176b
178b
ASC
Measured Response Times
Measured IOPS/ 100GB
Measured MBS/ 100GB
172n
174n
176n
178n
ASC
Measured Response Times
Measured IOPS/ 100GB
Measured MBS/ 100GB

FIG. 9

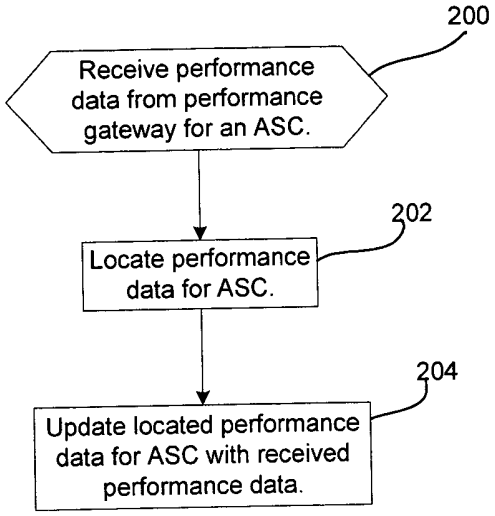

200
Receive performance data from performance gateway for an ASC.
202
Locate performance data for ASC.
204
Update located performance data for ASC with received performance data.

FIG. 10

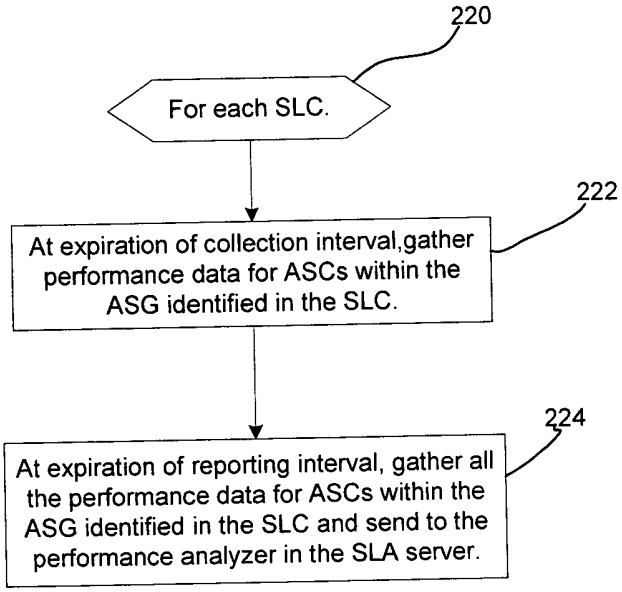

220
For each SLC.
222
At expiration of collection interval,gather performance data for ASCs within the ASG identified in the SLC.
224
At expiration of reporting interval, gather all the performance data for ASCs within the ASG identified in the SLC and send to the performance analyzer in the SLA server.

FIG. 11

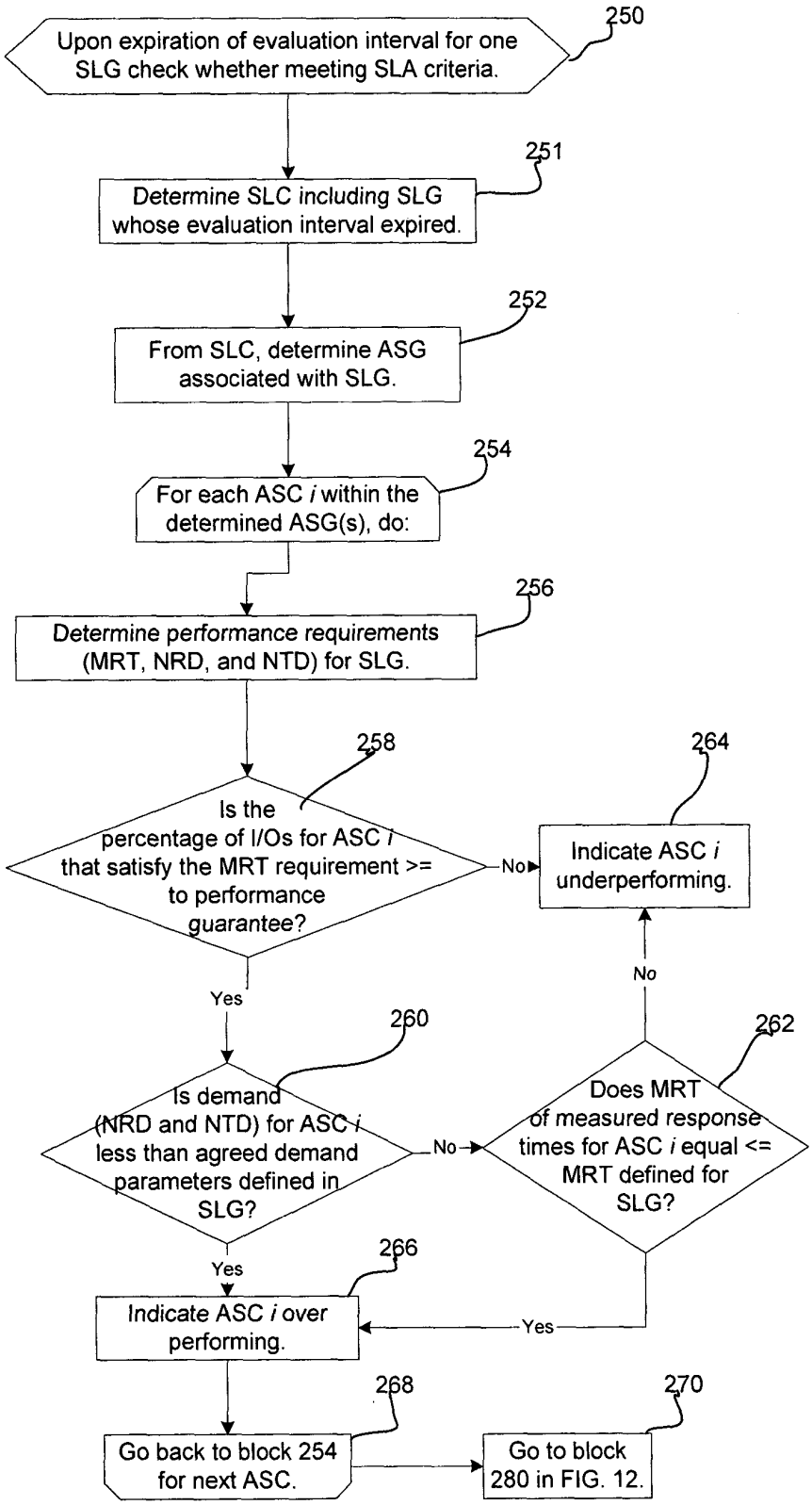

250
Upon expiration of evaluation interval for one SLG check whether meeting SLA criteria.
251
Determine SLC including SLG whose evaluation interval expired.
252
From SLC, determine ASG associated with SLG.
254
For each ASC i within the determined ASG(s), do:
256
Determine performance requirements (MRT, NRD, and NTD) for SLG.
258
Is the percentage of I/Os for ASC i that satisfy the MRT requirement >= to performance guarantee?
No
264
Indicate ASC i underperforming.
Yes
260
Is demand (NRD and NTD) for ASC i less than agreed demand parameters defined in SLG?
No
262
Does MRT of measured response times for ASC i equal <= MRT defined for SLG?
No
Yes
266
Indicate ASC i over performing.
Yes
268
Go back to block 254 for next ASC.
270
Go to block 280 in FIG. 12.

FIG. 12

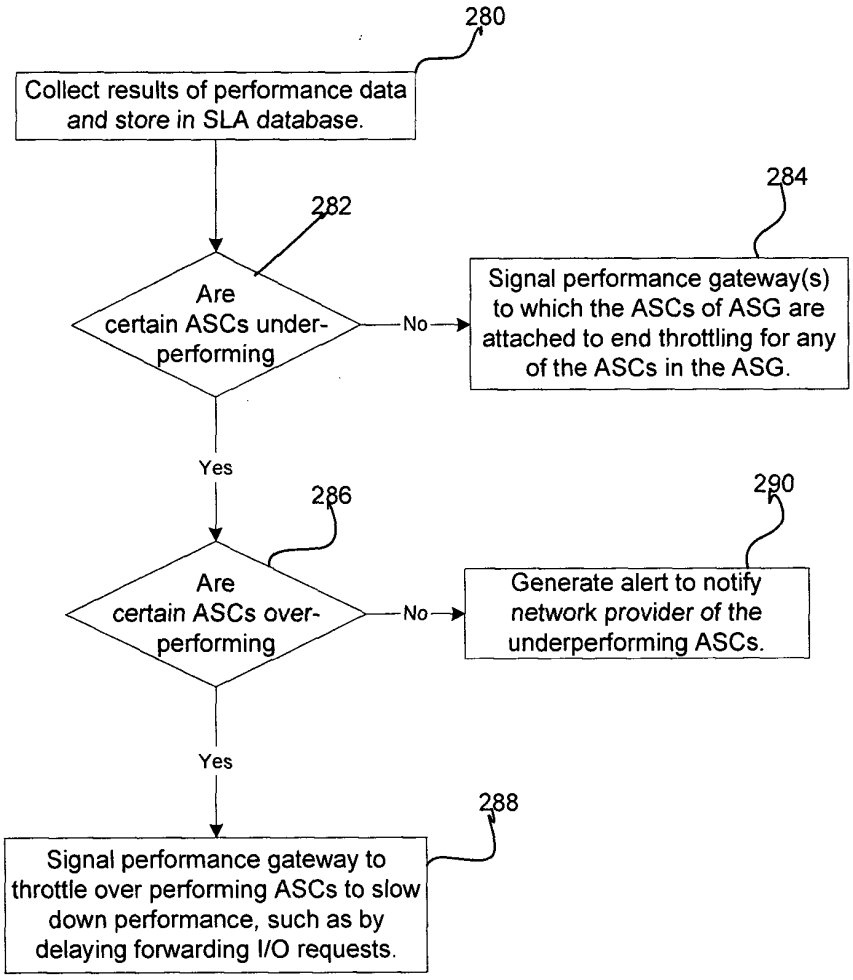

280
Collect results of performance data and store in SLA database.
282
Are certain ASCs under-performing
No
284
Signal performance gateway(s) to which the ASCs of ASG are attached to end throttling for any of the ASCs in the ASG.
Yes
286
Are certain ASCs over-performing
No
290
Generate alert to notify network provider of the underperforming ASCs.
Yes
288
Signal performance gateway to throttle over performing ASCs to slow down performance, such as by delaying forwarding I/O requests.

FIG. 13

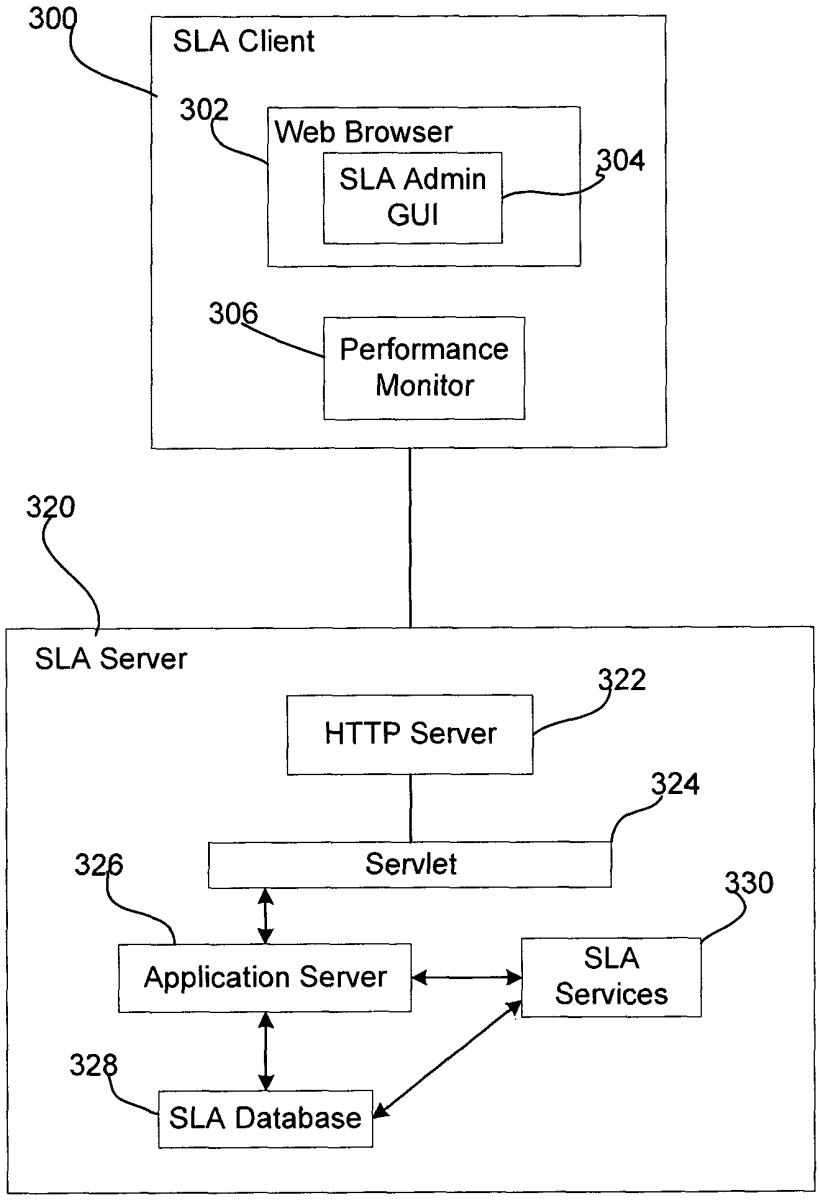

300
SLA Client
302
Web Browser
SLA Admin GUI
304
306
Performance Monitor
320
SLA Server
322
HTTP Server
324
Servlet
326
330
Application Server
SLA Services
328
SLA Database

FIG. 14a

```
<?xml version="1.0" ?>
<ASG ASG_Name="ASG_1">
  <ASC ASC_Name="ASC_1">
        <AppHost WWN="80" />
        <GatewayPort PortName="88" />
        <LogicDiskUnit PortableName="LU1">
          <CLUSTER_ID>1</CLUSTER_ID>
          <HLUN_ID>11</HLUN_ID>
      </LogicDiskUnit>
  </ASC>
    <ASC ASC_Name="ASC_2">
        <AppHost WWN="81" />
        <GatewayPort PortName="88" />
        <LogicDiskUnit PortableName="LU2">
          <CLUSTER_ID>2</CLUSTER_ID>
          <HLUN_ID>22</HLUN_ID>
      </LogicDiskUnit>
  </ASC>
    <ASC ASC_Name="ASC_3">
        <AppHost WWN="82" />
        <GatewayPort PortName="88" />
        <LogicDiskUnit PortableName="LU3">
          <CLUSTER_ID>3</CLUSTER_ID>
          <HLUN_ID>33</HLUN_ID>
      </LogicDiskUnit>
  </ASC>
    <ASC ASC_Name="ASC_4">
        <AppHost WWN="83" />
        <GatewayPort PortName="88" />
        <LogicDiskUnit PortableName="LU4">
          <CLUSTER_ID>4</CLUSTER_ID>
          <HLUN_ID>44</HLUN_ID>
      </LogicDiskUnit>
  </ASC>
</ASG>
```

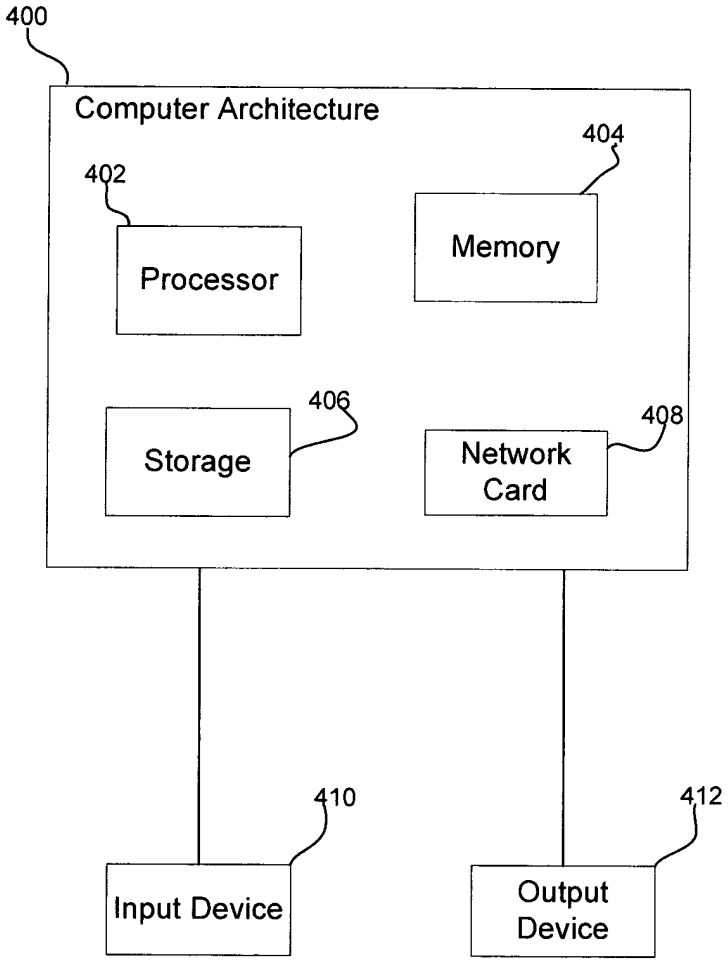
FIG. 14b

```
<?xml version="1.0" ?>
- <SLC>
    <SLC_Name>SLC_1</SLC_Name>
    <Author>John Smith</Author>
    <CustomerCode Major="ABC" Minor="123" />
    <SLG_Name>SLG_1</SLG_Name>
    <ASG_Name>ASG_1</ASG_Name>
    <ASG_Name>ASG_2</ASG_Name>
    <ASG_Name>ASG_3</ASG_Name>
    <ThrottlingPercentage>5</ThrottlingPercentage>
  - <RetentionPeriod>
      <Interval Value="24" Unit="hour" />
    </RetentionPeriod>
  - <Reporting>
      <Interval Value="60" Unit="sec" />
    </Reporting>
  </SLC>
```

FIG. 14c

```
<?xml version="1.0" ?>
- <SLG SLG_Name="SLG_1">
  - <SLG_Class ClassName="GOLD">
      <Priority>2</Priority>
    - <Evaluation>
        <Interval Value="10" Unit="ms" />
      </Evaluation>
      <PercentageGuarantee>95</PercentageGuarantee>
      <MRT UpperLimit="10" />
      <NDT LowerLimit="1" />
      <NDI LowerLimit="10" />
    </SLG_Class>
  </SLG>
```

FIG. 15


400
Computer Architecture
402
Processor
404
Memory
406
Storage
408
Network Card
410
Input Device
412
Output Device